IV. GROUNDWATER QUALITY

A. INTRODUCTION

In Rhode Island, groundwater is a locally abundant and widely used resource. Approximately 26% of the state's population is supplied with drinking water from public and private wells (Solley et al 1998). Groundwater resources are expected to meet a substantial part of the state's future water supply needs. Groundwater quality in most parts of the state is suitable for human consumption and other uses without treatment. Furthermore, protection of groundwater quality is important to protect surface water quality, since during dry periods, water in streams is derived almost entirely from groundwater.

Rhode Island's groundwater resources are extremely vulnerable to contamination because of the generally shallow depth to groundwater, aquifer permeability, and the absence of any subsurface confining layers. Preventing groundwater pollution must be a priority if the long-term quality of the State's groundwater resources is to be protected.

Over 100 different contaminants have been detected in Rhode Island groundwater, with the most common being petroleum products, organic solvents, nitrate and historically the pesticide aldicarb (Temik). Contaminant sources include leaking underground fuel storage tanks, hazardous and industrial waste disposal sites, illegal or improper waste disposal, chemical and oil spills, landfills, septic systems, road salt storage and application practices, and fertilizer and pesticide applications. Most groundwater contamination problems occur on a localized basis originating from a specific source. No public wells serving community systems or non-transient non-community systems were discontinued from service due to pollution from human activities during this reporting period (July 1995 – June 1999).

The Department of Environmental Management (DEM) is continuing to implement and refine a comprehensive groundwater protection program in response to legislative mandates and in response to the need to prevent further degradation of the state's valuable groundwater resources. This chapter of the report on the "State of the State's Waters" reviews available data on groundwater quality, discusses sources of groundwater contamination, and provides an overview of DEM's Groundwater Protection Program.

KEY FINDINGS
2000 REVIEW OF GROUNDWATER QUALITY IN RHODE ISLAND

* Groundwater remains an important component of the total volume of freshwater used in RI. The US Geological Survey estimates that 27 million gallons per day of groundwater were withdrawn in 1995. This constitutes 20% of the total freshwater used in the state. Approximately 26% of the state's population obtains its drinking water from groundwater sources.

* Groundwater in Rhode Island is generally free of pollutants, and in over 90% of the state it is considered suitable for drinking water use and other uses without treatment. No public wells serving community systems or non-transient non-community systems were discontinued from service during this reporting period (July 1995 – June 1999) due to pollution from human activities.

* The most frequently detected contaminants in public wells in RI, excluding compounds which are naturally occurring, are MTBE, a gasoline additive, and the widely used chemical solvents (e.g., trichloroethene, trichloroethane and tetrachloroethane). Nitrates are also a concern as they are often detected at concentrations far above natural background levels.

* A review of water quality data from community and non-transient non-community public wells indicates the vast majority of wells withdraw from a clean groundwater resource. On an annual basis, 87% to 89% of the wells had nitrate concentrations less than 3 mg/l, with five wells slightly exceeding the standard of 10 ppm. The annual percentage of wells with sodium levels less than 20 mg/l was 79%, and only three wells exceeded the advisory of 100 mg/l. Metals and pesticides were not detected in groundwater in concentrations that were of concern.

* Public well data does indicate that groundwater resources are vulnerable to contamination by volatile organic compounds (VOCs). Between 15% and 30% of the wells tested during this reporting period detected VOCs. However, only two non-transient non-community water supply wells were found to be above a drinking water standard.

* The leading cause of <u>new</u> groundwater contamination incidents reported to DEM continues to be the release of petroleum products stored in underground storage tanks.

B. GROUNDWATER USE

The US Geological Survey compiles water use data nationally every five years, and all of the information provided here on groundwater use is taken from the latest compilation by Solley, Pierce and Perlman in "Estimated Use of Water in the United States in 1995," US Geological Survey Circular 1200, 1998. The US Geological Survey estimates that for 1995, an average of 27 million gallons of groundwater was used per day in the state. This accounts for 20% of the total volume of freshwater used in Rhode Island on a daily basis (136 million gallons per day (mgd)).

Approximately two-thirds of Rhode Island municipalities utilize groundwater from public and/or private wells for all or a portion of their water supply needs. It is estimated that 26% of Rhode Island's population (262,000 people) depends on groundwater for domestic water use. Domestic water use includes water for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets and watering lawns and gardens. This includes 150,000 people supplied by public water and 112,000 people with an on-site source.

As of June 1999 there were 671 public wells in Rhode Island (RI Department of Health, Division of Drinking Water Quality). 168 of these wells are community wells, which serve residential populations of 25 persons or greater. The remaining 503 wells are non-community wells supplying schools, places of employment, hotels, restaurants, etc. Water provided by public water systems in Rhode Island amounted to 114 mgd, which is 84% of all freshwater used. Of this amount, 16 mgd was from groundwater (14%).

Information is not available on the amount of publicly supplied groundwater for non-domestic uses. Therefore, it is not possible to determine the total amount of groundwater supplied to specific non-domestic uses. However, information is available from the US Geological Survey (Solley et al 1998) on the amount of self-supplied groundwater: commercial – 1.5 mgd, industrial – 1.1 mgd, irrigation - .8 mgd, livestock - .5 mgd.

C. GROUNDWATER RESOURCES

Overview

Rhode Island's groundwater is contained in two types of aquifers: glacial deposits and bedrock. The unconsolidated glacial deposits overlie the bedrock and consist of stratified drift and glacial till. (See Figure 4-1 for a distribution of glacial deposits.) Groundwater moves readily between the stratified drift, till and bedrock aquifers and there is also a close hydraulic connection between these aquifers and the surface waters.

The state's most significant and productive aquifers are located in areas of stratified drift, which underlie approximately one-third of the state. Stratified drift consists primarily of well-sorted layers of silt, sand and gravel laid down by glacial meltwater streams. These deposits are usually located in existing stream valleys and in some cases they fill preglacial bedrock valleys. The stratified drift deposits are commonly 75 to 100 feet thick near the center of these valleys. Well yields vary depending on the thickness and permeability ranging from a few gallons per minute (gpm) to 1500 gpm, which is equivalent to approximately 2 million gallons per day.

In the 1970s the Rhode Island Water Resources Board mapped 22 groundwater reservoirs, which are the portions of the state's stratified drift aquifers that have the greatest potential for supplying future and existing public water systems with large quantities of groundwater. Groundwater reservoirs are defined as those areas of stratified drift with a saturated thickness of 40 feet or greater and a transmissivity of 4,000 ft. sq./day or greater. DEM modified the delineations for three of these groundwater reservoirs using more recently available information. DEM has mapped the critical portions of the recharge areas to the groundwater reservoirs using a modified version of a method developed by the U.S. Geological Survey (Trench and Morrissey, 1985; RIDEM 1991) (Figure 4-2). The groundwater reservoirs and the critical portions of their recharge areas are one component of the groundwater classified GAA, the highest protection class.

Glacial till, a second type of aquifer, typically consists of unsorted boulders, gravel, sand, silt and clay. The average thickness of till is 20 feet and it has a very low permeability. Wells dug in till have very low yields, generally less than 2 gpm, and often go dry during the summer months. Till deposits are not a suitable water supply source, and they function primarily to recharge underlying bedrock or downgradient stratified drift aquifers.

The third type of aquifer is the bedrock aquifer. In Rhode Island, bedrock consists mainly of granitic and gneissic rock with metamorphosed sedimentary rock found near Narragansett Bay. Groundwater in bedrock is stored and transmitted through fractures in the rock. Most bedrock wells yield less than 10 gpm. The U.S. Geological Survey (Johnston 1985) reports that over 90 percent of the wells drilled in bedrock provide an adequate yield for domestic water use. The majority of active private wells in Rhode Island are believed to be drilled into bedrock.

Background Groundwater Quality

The natural background quality of Rhode Island groundwater is considered excellent and suitable for human consumption. This is to be expected given that significant portions of the state depend on on-site private wells where the groundwater is not treated. This assessment may change in the future as decisions concerning the acceptable level of radon in drinking water are finalized, as will be discussed below.

The information available on natural background groundwater quality discussed herein is taken exclusively from the US Geological Survey (USGS) National Water Summary 1986 - Groundwater Quality (Johnston and Barlow 1988). Natural groundwater quality varies with local geologic conditions, and the data from the US Geological Survey is limited to dissolved solids, hardness, nitrate, iron, and manganese.

Stratified Drift Aquifers

Groundwater in the stratified drift aquifers has dissolved solids concentrations generally less than 100 mg/l. Concentrations are higher where there is infiltration from surface waters, on Block Island due to saline water, and where the stratified drift overlies sedimentary rocks

Figure 4- 1

Glacial Deposits

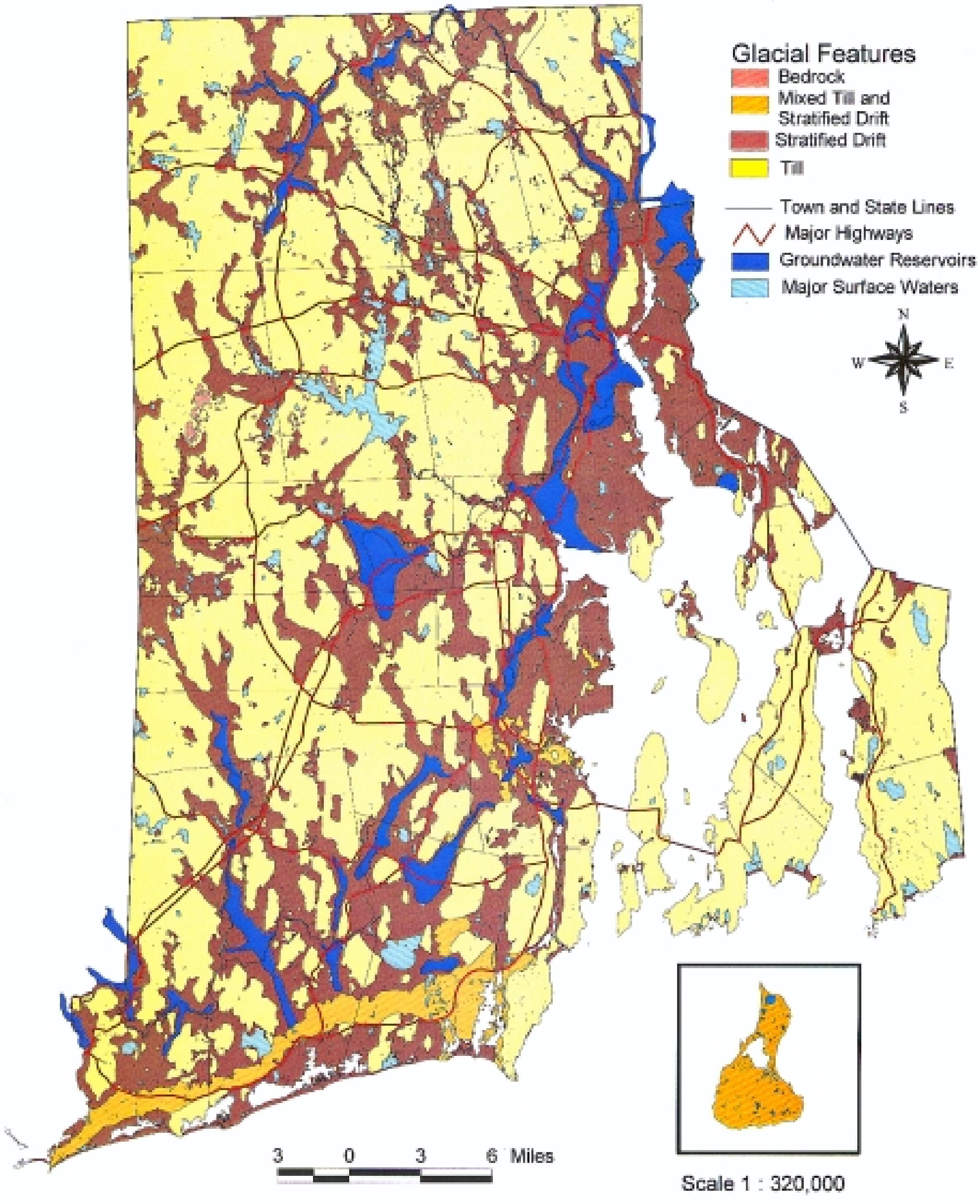
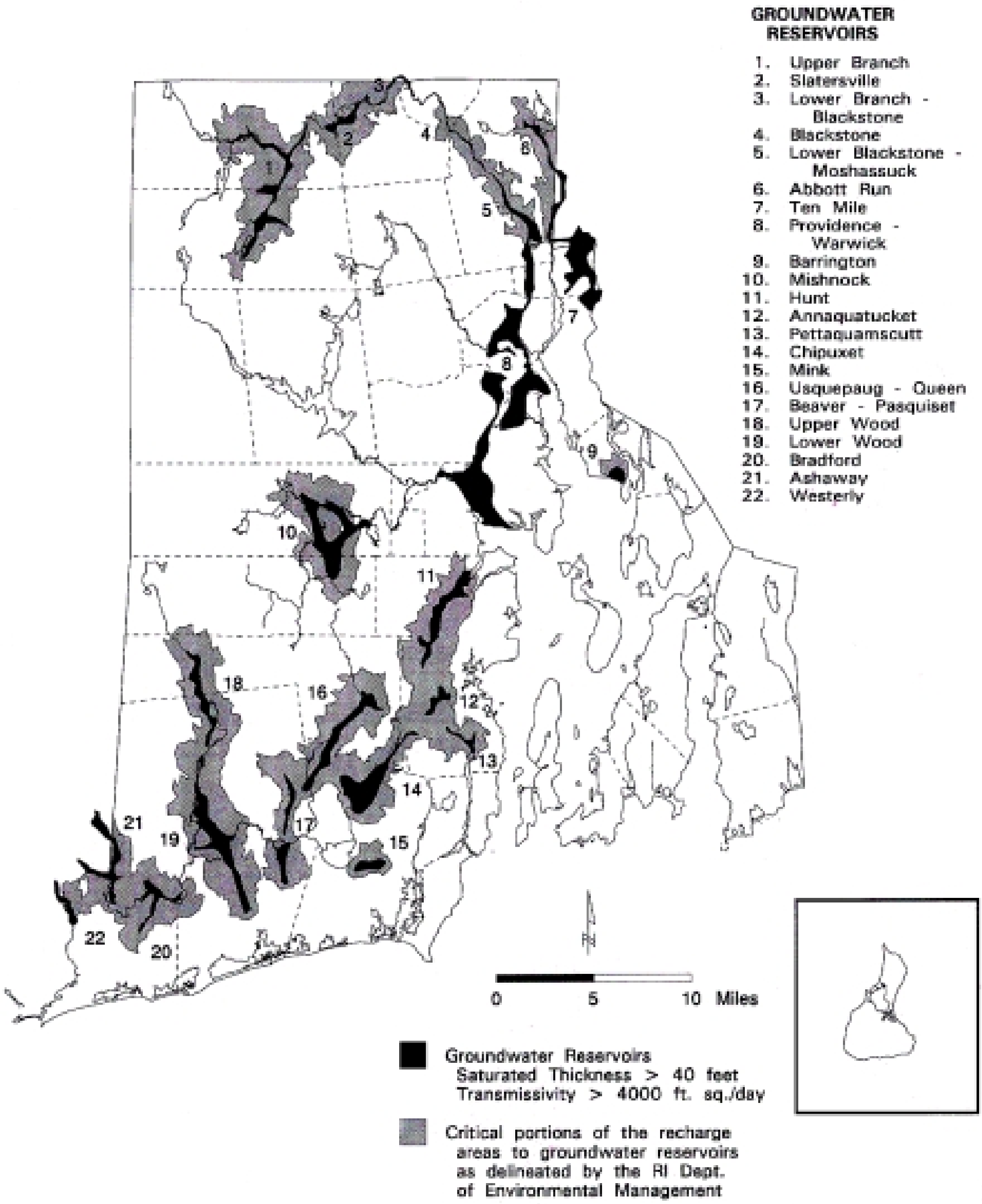


Figure 4-2.

Groundwater Reservoirs and the Critical Portions of Their Recharge Areas



(generally near Narragansett Bay). Groundwater is soft in most parts of the state due to the underlying granite bedrock.

Concentrations of iron and manganese are generally less than the secondary drinking water standards of .3 mg/l and .05 mg/l, respectively. Manganese concentrations can exceed .05 mg/l where pumping from wells located near surface waters has caused significant infiltration of surface water.

The concentrations of nitrate in groundwater in areas unaffected by human activities is likely to be less than .2 mg/l. This is the case in the upper Wood River basin where most of the land area is undeveloped and is managed by the state. Concentrations of nitrate in groundwater in most areas, assuming some human impacts, are expected to be less than 2 mg/l.

Bedrock Aquifers

The median concentrations of dissolved solids, hardness, and nitrate were 125, 66, and 2 mg/l, respectively, in samples from crystalline bedrock and 156, 95, and .3 mg/l, respectively, from sedimentary bedrock. The median concentration of iron was .07 mg/l from crystalline bedrock and .2 mg/l in samples from sedimentary bedrock.

Radon

Radon is a naturally occurring gas derived from the radioactive decay of uranium. Radon is soluble in groundwater, and it is most common where the underlying bedrock is granite and granite gneiss. Sand and gravel deposits derived from this bedrock can also be presumed to contain radon. The primary health concern from radon is in indoor air, most of which comes from the soil beneath the structure. Radon from drinking water is a smaller source of radon in indoor air (1-2%). Ingestion of drinking water with radon presents a health risk, but at a much lower level than the risk from inhalation of radon. The US EPA has proposed new regulations to protect the public from radon exposure that establishes 2 levels: a MCL of 300 pCi/l and an alternative maximum contaminant level of 4,000 pCi/l that can be used in conjunction with an EPA approved multimedia mitigation program for radon.

A study at the University of Rhode Island (Ruderman 1996) analyzed 101 groundwater samples for radon in the Pawcatuck River basin. Only two samples had concentrations less than 500 pCi/l. Forty-three samples exceeded 3,000 pCi/l, and 19 samples exceeded 10,000 pCi/l.

Radon was included in a portion of the DEM Private Well Survey conducted in the late 1980s. A total of 303 wells (310 analyses including duplicates) in 19 different areas throughout the state were tested for radon. The results for radon in groundwater range from 140 - 49,080 pCi/l. Table 4-1 summarizes the number of analyses that fall above specific radon concentrations in the Private Well Survey.

Table 4-1. Radon Concentrations from the DEM Private Well Survey

Radon Concentration in Groundwater (pCi/l)	Total Number of Analyses Above the Concentration
> 200	305
> 300	302
> 500	291
> 2,000	203
> 10,000	38
> 20,000	16
> 40,000	2

Wellhead Protection Areas

As part of the state's Wellhead Protection Program, DEM has delineated the wellhead protection areas (WHPAs) for the 671 public wells in Rhode Island. A wellhead protection area is the critical portion of the area through which water moves underground to a public well. (See Figure 4-3.)

For the community systems and the larger non-community systems, the WHPAs were delineated using a mathematical model in conjunction with mapping based on the hydrogeologic characteristics in the area. For the smaller non-community wells, WHPAs were designated as a circle with a radius of 1,750 feet which was derived from a hydrogeologic calculation. These DEM initial delineations are based on reasonably available hydrogeologic information and the well characteristics. DEM strongly recommends that many of these delineations be reviewed and refined using more site-specific data and possibly employing more complex methods.

The WHPAs cover 93,660 acres (14% of the state's land area) in 31 communities. The WHPA delineations for Rhode Island wells also include 1,912 acres in Connecticut and Massachusetts due to wells located along the state border. WHPAs for community wells cover 37,018 acres or about 5% of the state. Individual WHPAs range in size from approximately 15 acres (the smallest) to 2000 acres (the largest). The communities with the highest percentage of land area designated as WHPAs are Charlestown (38%), New Shoreham (35%), North Smithfield (35%), and Glocester (25%). For more information on Rhode Island’s Wellhead Protection Program refer to the RI DEM Wellhead Protection Program Biennial Report (October 1997- September 1999).

Figure 4 - 3

Wellhead Protection Areas

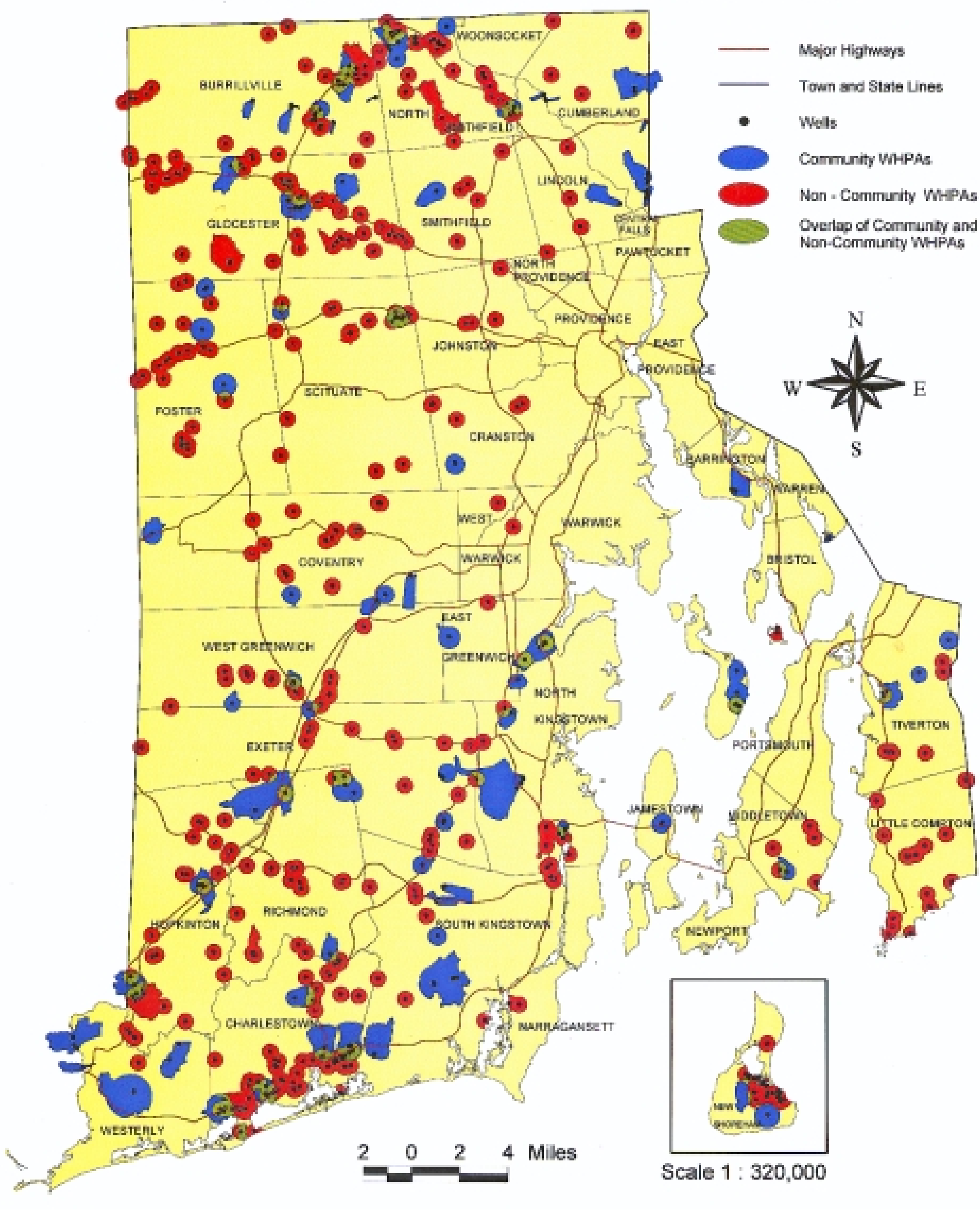
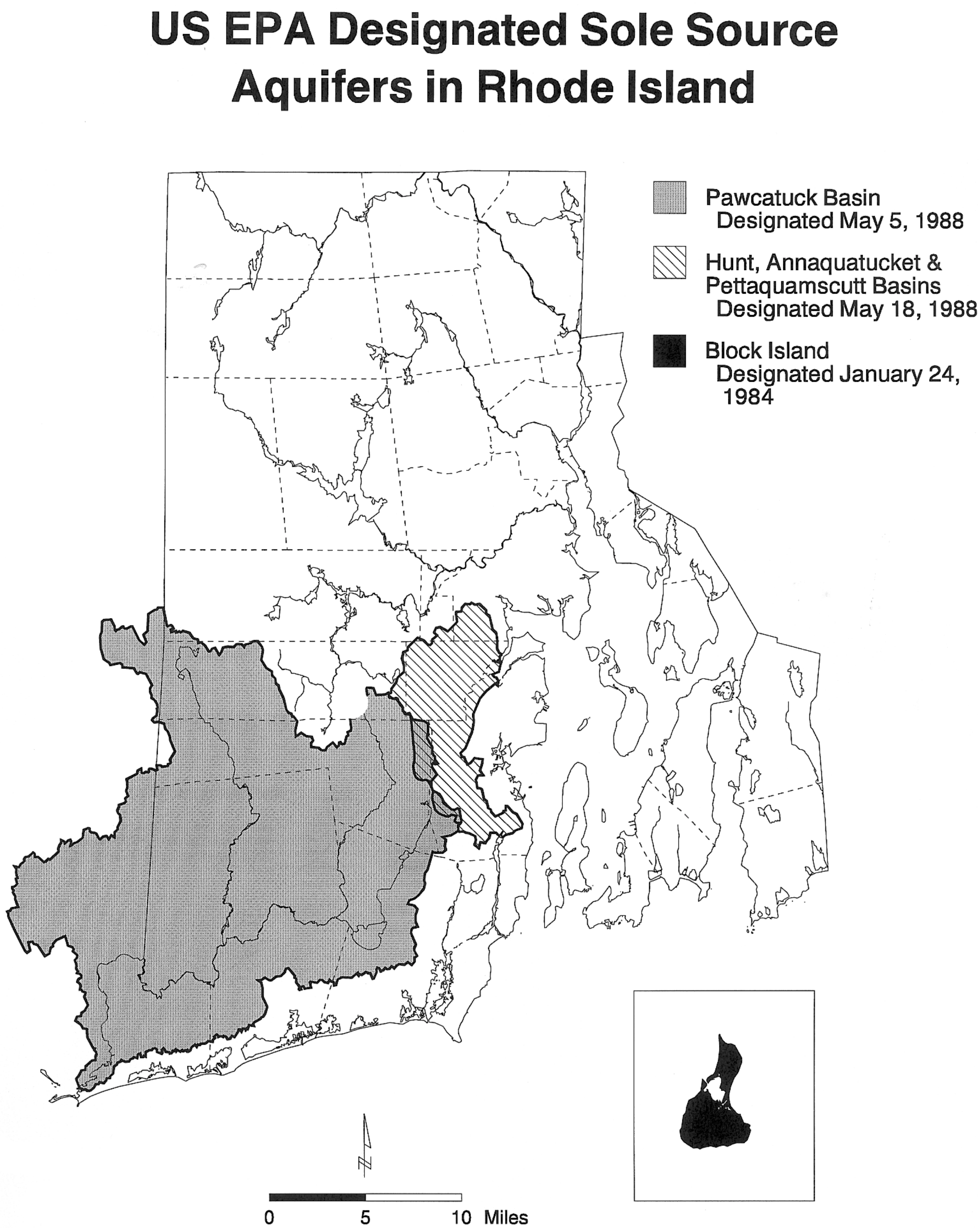


Figure 4-4.


US EPA Designated Sole Source Aquifers in Rhode Island
Pawcatuck Basin Designated May 5, 1988
Hunt, Annaquatucket & Pettaquamscutt Basins Designated May 18, 1988
Block Island Designated January 24, 1984
N
0
5
10 Miles

Sole Source Aquifers

Several areas of the state are entirely dependent on groundwater as a water source. This is the current situation in the towns of Little Compton, Westerly, Hopkinton, Richmond, Charlestown, South Kingstown, Narragansett, North Kingstown, Exeter, Foster, Scituate, Glocester, Burrillville, and West Greenwich.

In recognition that certain areas are dependent on groundwater, the U.S. Environmental Protection Agency (EPA) administers a sole source aquifer (SSA) program under authority of the Safe Drinking Water Act. To qualify as a SSA, an area must rely on groundwater for more than 50% of its drinking water supply and have no feasible supply alternatives, among other requirements. Block Island was designated a sole source aquifer in 1984. Two additional sole source aquifers were designated in Rhode Island in 1988 - the Pawcatuck Basin Aquifer System and the Hunt-Annaquatucket-Pettaquamscutt Aquifer System. The Pawcatuck SSA covers 295 square miles, and it encompasses part or all of ten towns in Rhode Island and four towns in Connecticut. The Hunt-Annaquatucket-Pettaquamscutt SSA covers 41 square miles located primarily in North Kingstown and East Greenwich. (See Figure 4-4.)

D. GROUNDWATER QUALITY ASSESSMENT - OVERVIEW

Over 100 different contaminants have been detected in Rhode Island's groundwater. The most frequently detected contaminants are methyl tertiary butyl ether (MTBE), a gasoline additive and the widely used chemical solvents (e.g., trichloroethene, trichloroethane and tetrachloroethane). Nitrates are also a concern as they are often detected at concentrations far above natural background levels.

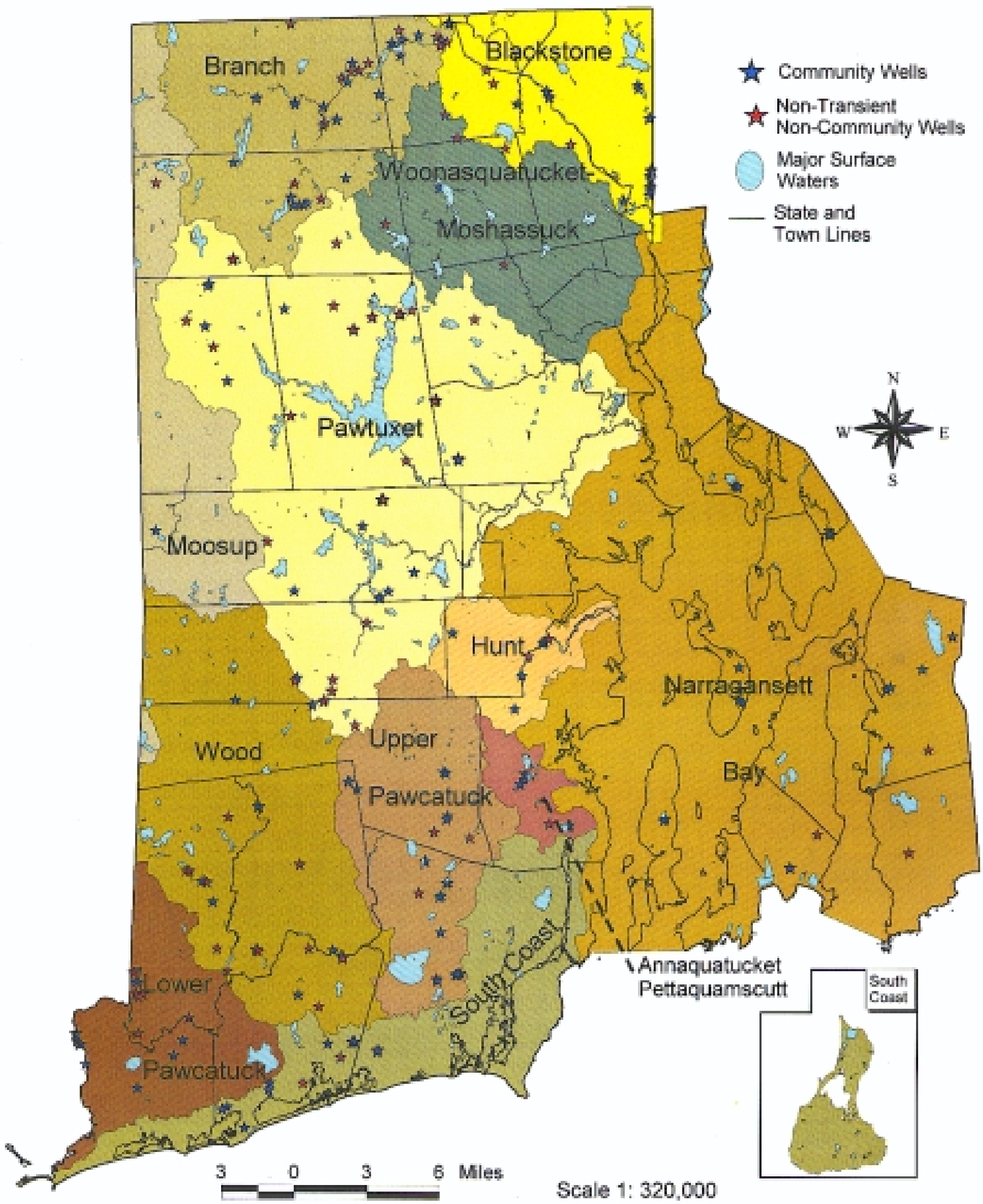
The state does not have a system of groundwater monitoring wells established for ambient groundwater quality monitoring. Therefore, groundwater quality data from public wells is used to assess groundwater quality in Rhode Island for this report. The well data used for this assessment is collected by the Rhode Island Department of Health (DOH). Drinking water quality standards, which are commonly referred to as maximum contaminant levels (MCLs), have been established by the US EPA and adopted by the RI DOH. In addition, health advisories (HAs) are used by the DOH for contaminants for which no MCL has been established. The maximum contaminant levels and health advisories are used in this report to evaluate the water quality data from public wells.

Public well data (see Section E) is considered to be the best indicator available for groundwater quality assessment, since these wells are regularly sampled for numerous parameters and they are widely distributed throughout those parts of the state dependent on groundwater for drinking water. Groundwater quality data available to the state from individual private home wells is a less reliable indicator since the majority of the wells sampled are in response to a known or suspected source of groundwater contamination.

In addition to public well data, information on sources of groundwater contamination has also been used as an indicator of the condition of and the threat to the state's groundwater resources. These sources are discussed in Section F. Monitoring well data from specific groundwater investigations and site assessments at known and suspected sources of

Figure 4 - 5

Groundwater Assessment Areas



contamination have not been analyzed. Compiling data from the hundreds of monitoring wells and samples taken to identify groundwater contamination problems would not provide useful information to characterize the overall groundwater quality in the state. Rather, DEM believes that tracking and reporting the number of sites that present a potential threat and those that have impacted groundwater is a more useful indicator.

The state has been divided into 12 groundwater assessment areas (as in the previous 305(b) report), which are shown in Figure 4-5. Since the major aquifers in RI are so closely hydrologically connected to surface waters, the assessment area boundaries were delineated using surface water basins and sub-basins in a manner that most reasonably recognized the major aquifers. Using surface water basins and sub-basins will also facilitate a more comprehensive approach to watershed management and overall water quality data analysis. The twelve assessment areas are: Annaquatucket-Pettaquamscutt, Blackstone, Branch, Hunt, Lower Pawcatuck, Moosup, Narragansett Bay, Pawtuxet, South Coast, Upper Pawcatuck, Wood, Woonasquatucket-Moshassuck.

E. PUBLIC WELL DATA

There is often confusion about the term "public well." Wells at hundreds of private establishments along with the major municipal wells are all by definition public wells. A public well supplies water to a public water system that is regulated by the DOH. These systems must meet specific water quality standards established by the federal government and enforced by the DOH. A public water system provides drinking water to 15 or more service connections or, regularly serves an average of at least 25 individuals daily at least 60 days of the year. Three categories of public water systems have been established:

* Community water system:
  - serves year-round residents;
  - at least 15 service connections or at least 25 individuals;
  - municipal wells and wells serving nursing homes, condominiums, and mobile home parks, etc.

* Non-transient non-community (NTNC) system:
  - regularly serves at least 25 of the same persons (not residents) over 6 months of the year;
  - schools and places of employment.

* Transient non-community system:
  - does not regularly serve the same persons;
  - does serve at least 25 people at least 60 days of the year;
  - restaurants and hotels.

The DOH water quality testing requirements for community systems and non-transient non-community systems are the same. The requirements for transient non-community systems are much less extensive. **The data on public wells reported in this document is from community and non-transient non-community systems only.** The DOH data is collected on the basis of the state fiscal year, which is from July 1 to June 30. The data in this report is from the 4 most recent fiscal years for which information is available:

July 1, 1995 to June 30, 1996
July 1, 1996 to June 30, 1997
July 1, 1997 to June 30, 1998
July 1, 1998 to June 30, 1999

It is difficult to make direct comparisons from year-to-year using the data collected by the DOH because different parameters have different sampling requirements. Therefore, with the exception of nitrate, the same wells are not necessarily tested every year for the same parameters that are discussed in this document. The DOH should be contacted for an explanation of the water quality sampling requirements.

In many cases a public water system sample was obtained from a source other than a well, such as a kitchen or bathroom tap. Although the well was not actually sampled, the data collected was attributed to that system's well water quality (filtered or treated samples were not included) and reported in the various tables as a well sampled. The following policies were followed in compiling the data:

* In cases where multiple samples were taken from the same public water system within the same year, and these samples were from both wells and other sources (e.g., kitchen tap), only the well data was used.

* In cases where multiple samples were taken from the same source within the same year, the highest values for the parameters of concern were used.

* In cases where multiple sources (not wells) were sampled within the same year, the highest values were used and the results were attributed to <u>one</u> well, even if the system had more than one well.

In this section, statewide <u>summary</u> information is provided for VOCs, SOCs, nitrate, and sodium. No public well serving a community system or a non-transient non-community system was discontinued from service during this reporting period due to pollution from human activities. The data is compiled on the basis of groundwater assessment areas in the Appendix to this chapter.

Volatile Organic Compounds

MTBE was the most frequently detected VOC in each of the 4 years in this reporting period (See Table IV-2). Trichloroethane (1,1,1-), a widely used solvent found in products used in the home and in commercial and industrial applications which historically has been the most commonly detected, was the next most frequently detected.

During this reporting period no community wells had an exceedance of an MCL/HA. One non-transient non-community well exceeded the MCL for tetracholoroethene in 1995-96 and one non-transient non-community well exceeded the MTBE HA for 3 years in a row from1995-96 – 1997-98. Although the data from 1991-1999 shows that there have been very few instances where an MCL/HA has been exceeded, VOCs are a continuing source of concern with 15-30% of the wells sampled annually having detections of VOCs. See Table IV-3 and Figure IV-6 for a summary of VOC data from public wells over the past 8 years.

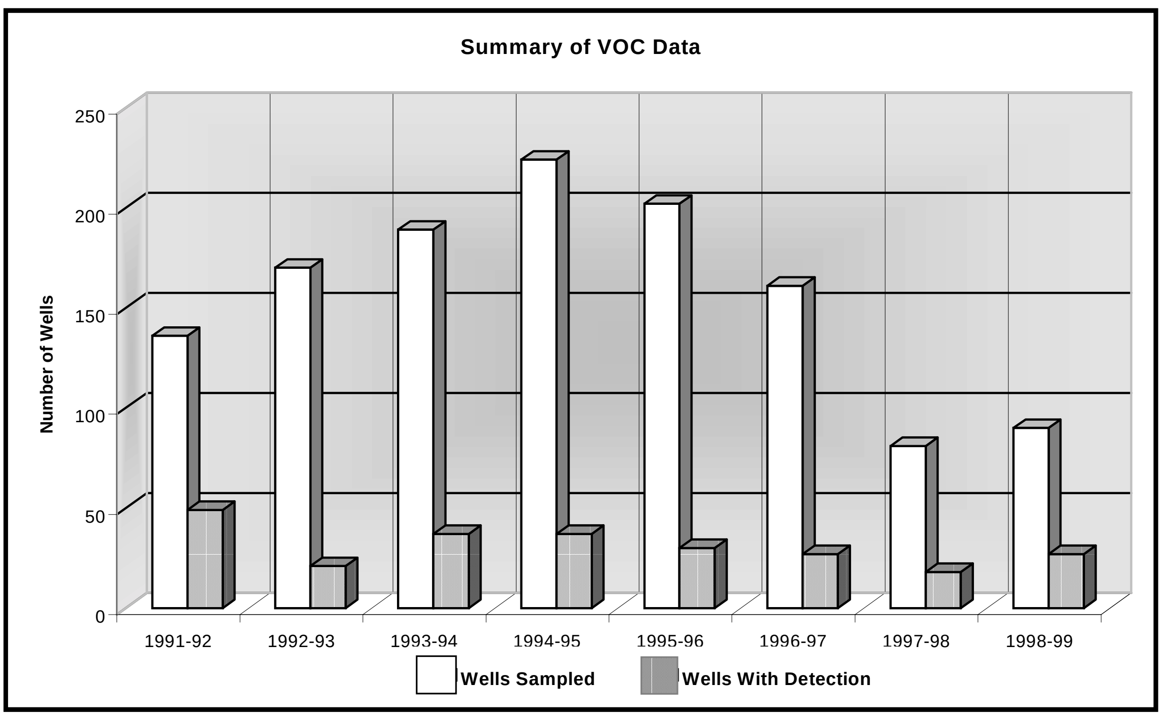
Table 4-2. Most Commonly Detected VOCs in Community and Non-Transient Non-Community Public Water Supply Wells – July 1995 to June 1999

Volatile Organic Compound	Number of Wells			
	1995-1996	1996-1997	1997-1998	1998-1999
Methyl tertiary butyl ether	8	11	11	18
Tetrachlorethene	4	4	4	3
Trichloroethene	3	2	3	3
1,1,1-Trichloroethane	8	6	5	7

Table 4-3. VOC Detections in Community and Non-Transient Non-Community Public Water Supply Wells -- July 1991 to June 1999

	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Number of Wells with VOC Detections > MCL/HA	11	2	3	1	2	1	1	0
Number of Wells with VOC Detections	49	21	37	37	30	27	18	27
Total Number of Wells Sampled	136	170	189	224	202	161	81	90
Percent of Wells with VOC Detections	36%	12%	20%	17%	15%	17%	22%	30%

Figure 4-6. Summary of VOC Data from Public Wells



Nitrate and Sodium

The data for community and non-transient non-community wells shows a consistent trend with respect to nitrate, which is contributed to groundwater primarily from septic systems and fertilizers (see Table 4-4). Five mg/l of nitrate, one-half the MCL, is often used as a threshold for determining acceptable impacts to groundwater from existing and proposed development. The annual percentage of wells that exceeded 5 mg/l during this assessment period averaged 5% (ranging from 4% to 6%). On an annual basis, 87% to 89% of the wells had concentrations less than 3.0 mg/l over the past 4 years. This is consistent with data from previous assessments which showed that on an annual basis over the 11 years from 1984-85 to 1994-95, the percentage of wells with concentrations less than 3.0 mg/l ranged from 84% to 93%.

There were 6 instances of an exceedance of the nitrate MCL in five wells during this assessment period. The highest concentration detected was 14.3 mg/l. For the prior 11 years from 1984-85 to 1994-95, there was only one instance of an exceedance of the MCL with a concentration of 11.7 mg/l in 1992-93.

Elevated concentrations of sodium in groundwater are caused primarily by road salt applications and saltwater intrusion. The DOH-recommended Alert Level intended to protect the most salt-sensitive individuals who are on medically monitored prescription diets is 20 mg/l. The annual percentage of wells that exceeded 20 mg/l during this assessment period averaged 21% (ranging from 17% to 24%)(see Table 5). Sodium data from previous assessments over the 11-year period from 1984-85 to 1994-95 showed an annual average of 19% of the wells with concentrations exceeding 20 mg/l (ranging from 14% to 28%).

At different times during this reporting period 3 wells exceeded 100 mg/l of sodium, which is the DOH-recommended Public Notification Level intended to protect the most salt-sensitive individuals who are not likely to be under strict, medical dietary care. Two of the wells serve the same water system and are located close to the coast, so salt water intrusion into the wells is likely to be the cause. These same two wells have had sodium concentrations repeatedly exceeding 100 mg/l over the years.

Table 4-4. Nitrate Data from Community and Non-Transient Non-Community Public Water Supply Wells – July 1995 to June 1999

Nitrate Concentration (mg/l)	Number of Wells			
	1995-1996	1996-1997	1997-1998	1998-1999
<0.20	72	87	84	72
0.21 – 3.0	103	102	113	105
3.1 – 4.9	17	15	14	12
5.0 – 10.0	8	8	10	9
>10.0	2	1	1	2
Total	202	213	222	200

Table 4-5. Sodium Data from Community and Non-Transient Non-Community Public Water Supply Wells – July 1995 to June 1999

Sodium Concentration (mg/l)	Number of Wells			
	1995-1996	1996-1997	1997-1998	1998-1999
<10	56	48	51	50
10.1 – 20.0	54	51	58	60
20.1 – 100	21	26	28	32
>100	2	1	0	2
Total	133	126	137	144

Pesticides and Other Synthetic Organic Compounds

Only 2 pesticides were detected in public wells during this reporting period – Metolachlor in 4 wells in the Upper Pawcatuck assessment area and Dieldrin in one well in the Wood assessment area. All concentrations detected were less than 1 part per billion (ppb), which is far less than the appropriate MCL or Health Advisory. It should be noted that the test methods used for drinking water analysis are not capable of detecting all of the pesticides that are used in RI or all of the chemicals resulting from the degradation of pesticides once they are in the environment.

Di(2-ethylhexyl)Adipate was found in 6 wells and Di(2-ethylhexyl)Phthalate was found in 2 wells. The 6 ppb MCL for Di(2-ethylhexyl)Phthalate was exceeded in both wells with concentrations of 20 ppb and 18 ppb. This is a significant difference from the previous 2-year reporting period in which Di(2-ethylhexly)Adipate was detected in 22 wells and Di(2-ethylhexyl)Phthalate was detected in 37 wells. It is believed that the chemicals are introduced to drinking water from sources other than contaminated groundwater. Plastic materials used in the water treatment or distribution systems and contamination of samples during laboratory analysis are possible sources of some of the contamination.

F. GROUNDWATER POLLUTION SOURCES

This section describes the variety of pollution sources that threaten Rhode Island's groundwater resources. Many of these sources are regulated by DEM, but others such as fertilizer use, road salt storage sites and road salt application, and pesticide use are not. DEM has identified the 10 highest priority sources of groundwater contamination in Table 4-6 using the EPA required format. The sources in this table are not ranked, but as the discussion in this section of the report will show, underground storage tanks are the major threat to the state's groundwater resources.

Table 4-6. Major Sources of Groundwater Contamination

Contamination Source	Ten Highest Priority Sources (✔)	Factors Considered in Selecting a Contaminant Source[1]	Contaminants [2]
Agricultural Activities			
Agricultural chemical facilities			
Animal feed lots			
Drainage wells			
Fertilizer applications	✔	D, B, C, H	E
Irrigation practices			
Pesticide applications			
On-farm agricultural mixing and loading procedures			
Land application of manure (unregulated)			
Storage and Treatment Activities			
Land application			
Material stockpiles			
Storage tanks (above ground)			
Storage tanks (underground)	✔	A, D, G	D
Surface impoundments			
Waste piles			
Waste tailings			
Disposal Activities			
Deep injection wells			
Landfills	✔	A	C, H, B, A
Septic systems	✔	D, B, C, A, H	E, J, K, L
Shallow injection wells	✔	D, A	C, D, H
Other			
Hazardous waste generators			
Hazardous waste sites	✔	A	C, D, H
Large industrial facilities	✔	A	C, D, H
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines			
Salt storage and road salting	✔	D, C, B, A	G
Salt water intrusion			
Spills	✔	D, A, B, C	D, C
Transportation of materials			
Urban runoff			
Small scale manufacturing and repair shops	✔	A, C, D, H	C, D, H
Other sources (please specify)			

Notes for Table 4-6:
(1) Factors used in selecting a contaminant source. They are indicated in the table in the order of importance.

A - Human health and/or environmental risk (toxicity)
B - Size of the population at risk
C - Location of the sources relative to drinking water sources
D - Number and/or size of contaminant sources
E - Hydrogeologic sensitivity
F - State findings, other findings
G - Documented from mandatory reporting
H - Geographic distribution/occurrence

(2) Contaminants/classes of contaminants considered to be associated with each of the sources checked:

A - Inorganic pesticides	G - Salinity/brine
B - Organic pesticides	H - Metals
C - Halogenated solvents	I - Radionuclides
D - Petroleum compounds	J - Bacteria
E - Nitrate	K - Protozoa
F - Fluoride	L - Viruses

Leaking Underground Storage Tanks

As of September 1999, a total of 3,463 actively used underground storage tanks (USTs) were registered with the DEM. This represents a significant decrease (30%) from the number reported in 1996. Facility owners are removing USTs that are not essential and often replacing several smaller USTs with fewer larger USTs. The main products stored in the tanks are gasoline (38%), #2 heating oil (47%), and diesel fuel (10%) (Figure 4-7). The USTs are located at 1847 facilities throughout the state. Approximately 25% (386) of the facilities are government owned. Commercial/industrial sites and gasoline retailers account for 35% (650 facilities) and 23% (433 facilities) respectively of the total.

These UST registration numbers do not include the thousands of home heating oil tanks that are less than 1,100 gallons in volume and therefore not directly regulated by DEM. As would be expected, most tanks are found in the more heavily developed urban and suburban areas of the state.

Leaking USTs (LUSTs), primarily from motor fuel facilities, have caused serious groundwater pollution problems in Rhode Island. Over 1183 LUST sites have been identified since 1985. While 33% of these sites were addressed by soil removal alone, the remainder required further field investigation. Active sites account for 44% and inactive sites 24%. The majority of these sites subsequently required active remediation of contaminated soil and groundwater. In several cases, restoration of the contaminated aquifers was deemed infeasible and public water lines were installed. Of the 1183 sites, 51 are in community WHPAs and 96 are in non-community (transient and non-transient) WHPAs (see Table 4-7). Table 4-8 provides the numbers of LUST sites by groundwater assessment area, and Table 4-9 shows the number of LUST sites by community.

Table 4-7. Leaking Underground Storage Tanks in Wellhead Protection Areas

Classification of LUST Sites	Number of LUST Sites			
	Within Community WHPAs	Within 1000 Feet of Community WHPAs	Within Non-Community WHPAs	Within 1000 Feet of Non-Community WHPAs
Active	25	6	59	44
Inactive	13	2	17	13
Soil Removal Only	13	5	19	12
Total	51	13	95	69

Figure 4-7. Products Stored in Underground Storage Tanks

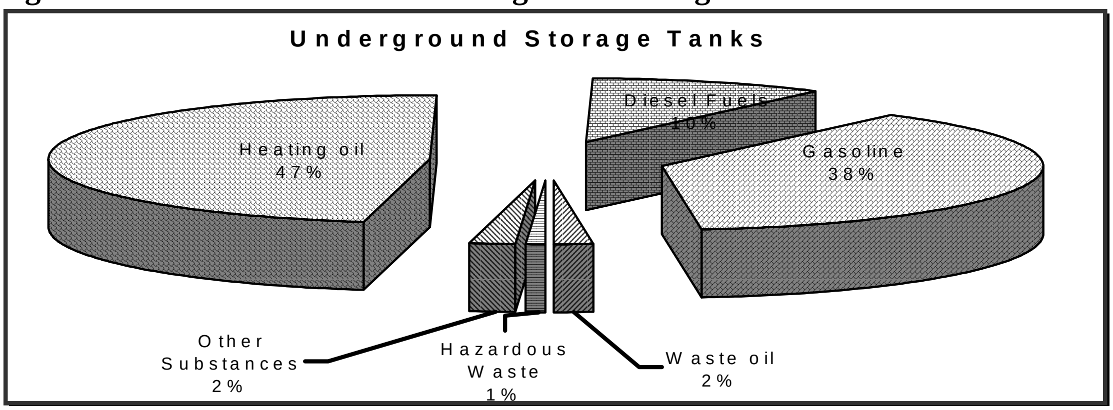


Table 4-8. Leaking Underground Storage Tank Sites in Groundwater Assessment Areas

Groundwater Assessment Area	Active	Inactive	SRO	Total
Annaquatucket – Pettaquamscutt	1	1	2	4
Blackstone	47	17	51	115
Branch	24	4	4	32
Hunt	9	6	2	17
Lower Pawcatuck	13	14	7	34
Moosup	6	1	1	8
Narragansett Bay	223	101	166	490
Pawtuxet	105	37	77	219
South Coast	29	18	25	72
Upper Pawcatuck	9	3	7	19
Wood	8	2	3	13
Woonasquatucket – Moshassuck	71	42	47	160
Total	**545**	**246**	**392**	**1183**

Table 4-9. Leaking Underground Storage Tank Sites by Municipality

Community	Active	Inactive	SRO	Total
Barrington	4	4	4	12
Bristol	7	6	10	23
Burrillville	13	2	3	18
Central Falls	3	4	6	13
Charlestown	4	3	3	10
Coventry	14	7	4	25
Cranston	33	9	30	72
Cumberland	18	7	19	44
E. Greenwich	9	5	3	17
E. Providence	21	14	24	59
Exeter	3	0	3	6
Foster	6	1	1	8
Glocester	7	1	0	8
Hopkinton	5	2	4	11
Jamestown	5	2	3	10
Johnston	13	4	10	27
Lincoln	9	5	9	23
Little Compton	5	2	0	7
Middletown	16	6	17	39
Narragansett	8	3	5	16
New Shoreham	5	0	1	6
Newport	25	14	19	58
N. Kingstown	16	9	13	38
N. Providence	11	8	4	23
N. Smithfield	13	4	2	19
Pawtucket	29	12	22	63
Portsmouth	8	2	9	19
Providence	77	35	57	169
Richmond	5	1	1	7
Scituate	8	3	2	13
Smithfield	8	8	4	20
S. Kingstown	19	16	18	53
Tiverton	12	2	4	18
Warren	12	8	11	31
Warwick	43	13	28	84
W. Greenwich	1	2	0	3
W. Warwick	20	7	13	40
Westerly	11	14	6	31
Woonsocket	17	3	20	40
Total	543	248	392	1183

(1) Communities in bold are entirely dependent on groundwater for their drinking water supply.
(2) SRO means Soil Removal Only

Waste Sites

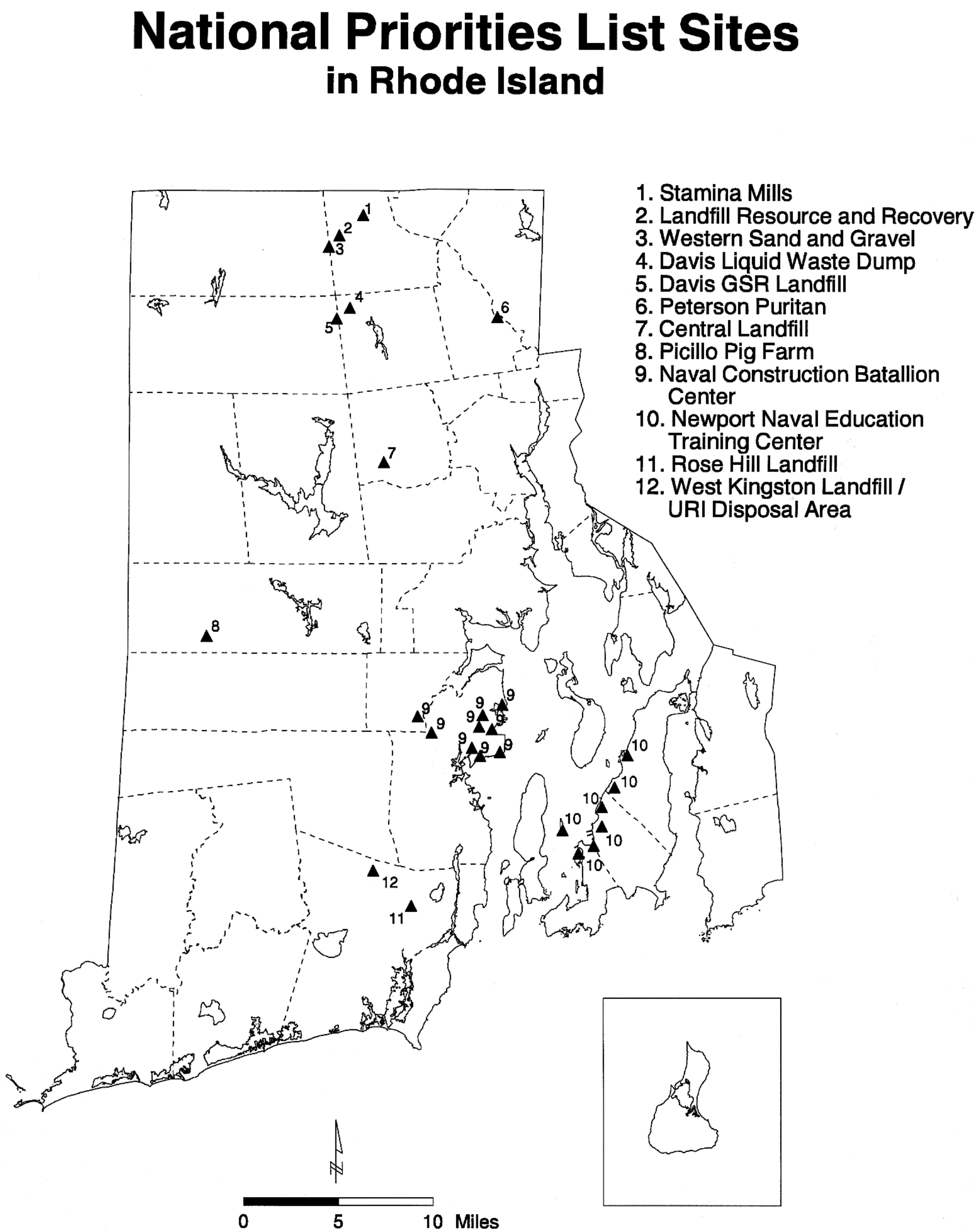
This category includes a variety of different sources of groundwater contamination resulting from waste disposal (both legal and illegal), spills and other accidents at municipal landfills and dumps, commercial and industrial facilities, and federal defense sites. An accurate and comprehensive reporting of sites in this category is not possible at this time due to the lack of a comprehensive DEM database for tracking contamination sources.

DEM and EPA maintain a list of known and potential hazardous waste sites under the federal CERCLA Program known as the CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) list, which is EPA's system for tracking these waste sites within the jurisdiction of the "Superfund" Program. The CERCLIS list for Rhode Island includes 290 sites. Twelve CERCLA sites are included on the Superfund National Priorities List (see Figure 4-8). All twelve of these Superfund sites are known to have contaminated groundwater, primarily with volatile organic compounds. Table 4-10 provides a breakdown of the location of the CERCLA sites by groundwater assessment area. It is important to note that not all CERCLA sites have impacted groundwater quality.

Table 4-10. CERCLA Sites in Groundwater Assessment Areas

Groundwater Assessment Area	Total Number of CERCLA Sites	CERCLA Sites Designated NPL Sites
Annaquatucket-Pettaquamscutt	3	0
Blackstone	19	1
Branch	20	3
Hunt	7	0
Lower Pawcatuck	1	0
Moosup	1	1
Narragansett Bay	104	2
Pawtuxet	68	1
South Coast	12	1
Upper Pawcatuck	12	1
Wood	10	0
Woonasquatucket-Moshassuck	33	2
Total	**290**	**12**

Figure 4-8. National Priorities List Sites in Rhode Island



Subsurface Discharges

Underground Injection Control Sites

The Rhode Island Underground Injection Control (UIC) Program Rules and Regulations require that Department approval be obtained prior to installation of an on-site subsurface disposal system utilized for non-sanitary wastewater disposal. All discharges must meet specific water quality criteria. In addition to the Department approval of all proposed discharges, facility owners must register and provide data to ensure that existing systems, at minimum, meet the effluent quality criteria or close the system under the direct oversight of the Program.

As of October 1999, nearly 600 facilities with active, formerly active, or suspected discharges have been investigated and regulated by the Rhode Island UIC Program. There are four types of disposal wells that make up approximately 98% of the known UIC systems contained in the UIC Program database. A breakdown of the various types of identified UIC disposal systems located statewide is given in Table 4-11. A brief description of each follows.

Motor Vehicle Waste Disposal Wells – dry wells, galleys, leachfields, septic systems and other structures that receive or have received fluids from vehicular repair or maintenance activities through garage bay floor drains. Facilities included in this category are auto body repair shops, automotive repair shops, new and used car dealerships, transmission shops, muffler repair shops, or any facility where vehicular repair work is performed.

Stormwater Drainage Wells – dry wells, galleys, leachfields, infiltrators, flow diffusors and other structures that receive stormwater runoff from commercial and industrial parking areas, residential subdivisions and roadways.

Industrial Waste Disposal Wells – dry wells, galleys, leachfields and other structures that receive wastewater from manufacturing processes. This category also includes those stormwater drainage wells located at industrial facilities that may be susceptible to chemical and petroleum releases from loading docks and fueling areas.

Aquifer Remediation Wells – structures that receive wastewater from groundwater recovery and treatment systems at facilities where chemical and/or petroleum releases have impacted groundwater quality.

The additional disposal systems that complete the inventory include non-contact cooling water wells, heat pump and air conditioning return flow wells, and geothermal direct heat wells.

As indicated, the most significant number of UIC disposal systems reviewed to date are associated with motor vehicle maintenance facilities. This is primarily a result of statewide inventory efforts begun in the early 1990s targeting major oil company facilities, public maintenance facilities, and other high risk uses in the most sensitive groundwater areas. Nearly half of all facilities with identified UIC systems are located in areas where the groundwater is classified GAA or GA. A majority of the systems identified at vehicle maintenance facilities are considered high-risk for groundwater contamination, and therefore have been permanently closed.

During November 1999, the US EPA revised a portion of the federal UIC Regulations which phases in a ban of all new and existing motor vehicle waste disposal wells beginning in April 2000. Additional UIC system closures are expected to continue based on this action.

Table 4-11. UIC Disposal Systems

Type of Well	Number Registered	
Motor Vehicle Waste Disposal	239	(41%)
Stormwater Drainage	163	(28%)
Industrial Waste Disposal	145	(25%)
Aquifer Remediation	21	(4%)
Other	11	(2%)
Total	**579**	

Of the total 579 registered UIC facilities in the state, 252 have active discharges under approval, more than half have permanently abandoned their UIC systems, and the remainder are undergoing investigation of suspected discharges or are currently under review for approval.

Septic Systems

Septic systems are a widespread potential source of groundwater pollution. DEM has standards for the design, construction and installation of septic systems and has a well established program for permitting all new construction, repairs and alterations of septic systems. Each septic system creates its own small area of degraded groundwater quality that in most cases poses no problems for on-site drinking water wells and nearby surface waters. However, there are instances of well contamination and impacted surface waters suspected to be caused by septic systems, many of which are likely to be substandard systems. The primary pollution concerns are nitrates, bacteria and viruses from human waste and toxic chemicals from the improper disposal of hazardous chemicals.

The 1990 census (US Department of Commerce 1993) shows that 120,671 housing units (approximately one-third of the housing units in the state) depend on a septic tank, cesspool or some means other than a public sewer system for their wastewater disposal. The previous 305(b) report indicated that approximately 6500 additional new systems were installed in RI from 1990 to July 1995. From July 1995 to June 1999, 7154 new systems were installed, bringing the total to approximately 134,000 septic systems in RI. In addition, the DEM records indicate that from July 1995 to June 1999 4724 systems were repaired and 565 were altered.[1]

[1] A "repair" to a septic system is work done to mend or remedy a specific defect or deficiency after the failure, injury, deterioration or partial destruction of a previously existing system. An "alteration" to a septic system refers to any modernization, modification or change in the size or type of an existing system.

Solid Waste Disposal Facilities

Landfills and dumps have always been the primary means of solid waste disposal in Rhode Island. Over the years the number of active facilities has steadily decreased to the point where currently there are only 3 active facilities operating under licenses from the DEM-Office of Waste Management as "Subtitle D" solid waste facilities – municipal landfills in Bristol and Tiverton, and the Central Landfill in Johnston, which is owned and operated by the Rhode Island Resource Recovery Corporation.

The Central Landfill, which receives over 90% of the state's solid waste, is New England's largest municipal waste facility covering 154 acres. A large quantity of hazardous waste was disposed of at the landfill in the 1970s resulting in the site being included on the National Priorities List for hazardous waste clean-up. Due to the presence of contamination at the Central Landfill, much concern has been expressed over the years about the potential of this contamination to affect the Scituate Reservoir, which supplies drinking water to over 50% of the state's population. The Central Landfill is over 2 miles east of the Scituate Reservoir and is located outside of its watershed. During the past ten years, numerous studies have been conducted on the groundwater and groundwater flow in the vicinity of the landfill. Thus far, all studies have indicated that there is no evidence of shallow groundwater flow from the landfill toward the Scituate Reservoir. In addition, there is no evidence that deep bedrock fractures from Central Landfill to the Scituate Reservoir are hydraulically connected.

Road Salt Storage and Application

Wherever road salt (sodium chloride) has been stored improperly for extended periods of time, groundwater is likely to be adversely impacted. The degree of degradation is dependent on the management practices employed at the site. Mitigating measures to prevent groundwater contamination from road salt storage sites include covering the salt piles, placing them on impermeable surfaces and containing the salt-laden runoff from the site.

A DEM survey conducted during the winter of 1999-2000 identified 23 active state owned salt storage sites in Rhode Island. Twenty of these sites are in areas where the groundwater is classified GAA or GA. The remaining three sites are located where the groundwater is classified GB. Recognizing the potential threat that the salt piles pose to the state's water resources, the Rhode Island Department of Transportation has constructed salt storage structures for 11 of the sites.

Forty-two active municipal salt storage sites were identified in the recent survey. Twenty-seven of these sites are in areas where the groundwater is classified GAA or GA, and 15 are in areas where the groundwater is classified GB. Sixteen of these municipal salt storage piles are under permanent cover.

There are additional salt storage piles located throughout the state under the control of private individuals and companies. No attempt has been made to inventory these salt piles, and there have been no reported incidents of groundwater contamination due to these private sector salt piles.

In an effort to provide for safe winter travel, road salt is used on both state and local roads. There is no data available on the amount of road salt used in the state. The application rate for the Rhode Island Department of Transportation is usually on the order of 150-300 pounds per lane mile per application depending on the nature of the storm and the road being serviced. Local governments generally use road salt more sparingly, relying on sand wherever possible. Many municipal wells are located in close proximity to major roads and a number of these wells have levels of sodium approaching or exceeding 20 mg/l.

Pesticides and Fertilizers

Information on pesticide use collected by the DEM Division of Agriculture is derived from certified applicator reporting on use of restricted use pesticides. All other pesticides ("general use pesticides") are not required to be reported. As described in the "State of Rhode Island Pesticide, Fertilizer, and Water Resources Assessment" (1998)(referred to as the "Assessment"), the result is an incomplete picture of pesticide use in the state.

The "Assessment" revealed that 223 pesticides were reported applied in the State from 1989 – 1996. Pesticides are divided into four categories (listed in order of frequency applied): insecticides, herbicides, fungicides, and others. Of the ten most frequently reported pesticides in each of the three categories--insecticides, herbicides, and fungicides -- applied in Rhode Island, only 5 of these pesticides have ever been detected in the state's water resources.

Of the three primary nutrients in plant fertilizers - nitrogen, phosphorous and potassium - nitrogen is the only one considered a threat to groundwater quality. Nitrogen, as nitrate, is soluble and moves freely with the groundwater. Elevated concentrations of nitrogen have been documented from fertilizer use.

Because of Rhode Island's relatively small percentage of land area in agriculture, agricultural use of fertilizers and pesticides is less of a statewide threat than residential use. Homeowner use is reported by the Division of Agriculture as accounting for approximately 80% of the total fertilizer tonnage used in the state. Homeowner use of pesticides does not require reporting. As a result, homeowners represent the largest unregulated group of pesticide applicators in the state. In 1988, the DEM Division of Agriculture conducted a survey of household pesticide users. As discussed in "Rhode Island's Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer" (1996), 49% of the 300 households surveyed reported applying pesticides to their property. Of these applications, 37% were of the type most likely to affect groundwater (20% lawn care, 9% ornamentals, 7% vegetables, and 1% termites). Homeowners must recognize their responsibility in preventing groundwater quality degradation from nitrate fertilization and pesticide application.

G. GROUNDWATER PROTECTION PROGRAM

The Rhode Island Groundwater Protection Act of 1985 (Title 46 Chapter 13.1) set forth for the first time a vigorous policy for protecting the groundwater resources of the State. The Act established that it is state policy "to restore and maintain the quality of groundwater to a quality consistent with its use for drinking supplies and designated beneficial uses" and to restore all groundwater of the state to the extent practicable to a quality consistent with this policy (46-13.1-2(4)). In addition, the Act prohibits the introduction of "pollutants into the groundwater of the state in concentrations which are known to be toxic, carcinogenic, mutagenic, or teratogenic", and mandates "to the maximum extent practical, efforts shall be made to require the removal of such pollutants from discharges where such discharges are shown to have already occurred" (46-13.1-2(5)).

The state of Rhode Island administers a number of different programs with groundwater protection as either the sole objective or one of several objectives. These programs work cooperatively with the federal programs. The need to coordinate and integrate these state programs, in addition to local government protection efforts, was recognized in the Rhode Island Groundwater Protection Strategy (RIDEM 1989). A large majority of the recommended actions outlined in the Strategy have been implemented by DEM and other agencies. DEM will initiate efforts to revise the strategy in 2001.

The elements of the state's groundwater protection program are summarized using the EPA provided format in Table 4-12. As is evident from this table, an effective program has many key elements from pollution source control to resource identification to protection planning. A list of the state regulations that pertain to groundwater protection is provided in Table 4-13. The remainder of this section will describe four programs that establish a framework for groundwater protection in Rhode Island.

Groundwater Classification and Standards

The Groundwater Protection Act mandated the development and implementation of a statewide groundwater classification system. The DEM "Rules and Regulations for Groundwater Quality," promulgated in 1992, classified the state's groundwater resources into four classes and established groundwater quality standards for each class. The classification system provides a means for setting priorities in the State's regulatory and enforcement programs. The four classes are designated GAA, GA, GB, and GC. Within these classes, areas of non-attainment have been designated where the groundwater is known or presumed to be out of compliance with the groundwater quality standards for the assigned classification. See Figure 4-9 for a map of the groundwater classification delineations in Rhode Island.

Groundwater classified GAA and GA is known or presumed to be suitable for drinking water use, and is to be protected to maintain drinking water quality. Groundwater classified GAA, the highest protection class, includes the state's major stratified drift aquifers, wellhead protection areas for community water supply wells, and Block Island. GAA classified groundwater underlies approximately 20% of the state. Groundwater classified GA is also known or presumed to be suitable for drinking water use, but it is not within one of the priority areas designated GAA. GA classified groundwater underlies approximately 70% of the state.

Groundwater classified GB and GC is known or presumed to be unsuitable for drinking water use without treatment. The areas where groundwater is classified GB (9% of the state) are primarily the major urban centers of the state. Public water is available where groundwater is classified GB. Although there is no goal to restore groundwater classified GB to drinking water quality, groundwater remediation is often required to protect public health and the environment. Groundwater classified GC is limited to the current DEM permitted waste disposal area at solid waste landfills.

Wellhead Protection Program

The Rhode Island WHP program, which was approved by the U.S. Environmental Protection Agency in 1990, was prepared in accordance with the federal Safe Drinking Water Act. The program provides a mechanism for increased protection of groundwater supplied by public systems through efforts at the state and local level. The primary emphasis of the state is to set a high priority for source control and remediation efforts in wellhead protection areas (WHPAs) and to provide local governments and suppliers with the technical information and administrative tools necessary to use local authorities and initiatives to protect groundwater quality in WHPAs.

The focus of the WHP program is the area contributing water to a public well, which is called the wellhead protection area (WHPA). The three key elements of Rhode Island's WHP program are briefly described below. For more information on the WHP Program see the 1999 WHP Program Biennial Report.

1) Delineation of the WHPAs. Delineations were completed by DEM and provided to each water system owner and municipality. DEM periodically updates the statewide WHPA map. (See Figure 4-3.) DEM encourages the development of more refined delineations using more site-specific data and possibly employing more complex methods.

2) Identification of known and potential sources of groundwater contamination within the WHPAs. This is the responsibility of the towns and the 15 large water suppliers. The procedure involves a field survey of the WHPA and a review of state records to collect information about facilities located in the WHPA. 82% of the required inventories have been submitted and approved by DEM. 95% of the community water systems and 82% of the non-community water systems are addressed by a completed inventory.

3) Development of local WHP plans. The large water suppliers and the municipalities must develop a plan to protect groundwater quality within their WHPAs. Each community and large supplier will determine the most appropriate protection strategies given their own unique circumstances. 52% of the community water systems and 25% of the non-community water systems are addressed by an approved WHP Plan.

Source Water Assessment Program (SWAP)

The Rhode Island Department of Health is responsible for the development and implementation of the Source Water Assessment Program (SWAP), which was established by the 1996 amendments to the Safe Drinking Water Act. The purpose of the Program is to assess the threats to sources of public drinking water and determine the water supply's susceptibility to these threats. The Rhode Island Source Water Assessment Program has been approved by EPA, and the Department of Health has just recently begun implementation of the Program. There are 4 basic requirements of the SWAP:

1) Delineate the area that contributes water to the source, referred to as the source water protection area. For wells, this is the DEM wellhead protection area;

2) Inventory the source water protection areas for potential sources of contamination;

3) Assess the risk associated with each potential source of contamination and evaluate the overall susceptibility of the water supply to contamination;

4) Make the results of the assessments known to the suppliers and consumers of public water.

Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer

The DEM Division of Agriculture has developed "Rhode Island's Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer" (1996). This is a statewide strategy to prevent the contamination of groundwater by pesticides and nitrogenous fertilizers originating from agriculture, landscape, and ornamental uses. The Plan outlines an approach to site specific monitoring and the actions that will be taken in response to contamination.

A "State of Rhode Island Pesticide, Fertilizer and Water Resource Assessment" was completed in 1998 to provide baseline information upon which individual Pesticide State Management Plans can be developed. A specific state management plan for each of the following pesticides is required by the US EPA (pesticides are listed in the order of their use in Rhode Island): Atrazine, Metolochlor, Alachlor, Cyanazine and Simazine. A Metolachlor Management Plan is currently under development.

Table 4-12. Summary of Rhode Island Groundwater Protection Programs

Programs or Activities	Check (✓)	Implementation Status[1]	Responsible State Agency[2]
Active SARA Title III Program	✓	A	DEM
Ambient groundwater monitoring system			
Aquifer vulnerability assessment			
Aquifer mapping	✓	E	USGS
Aquifer characterization	✓	E	USGS
Comprehensive data management system *(regulated facilities and potential pollution sources)*	✓	D	DEM
EPA-endorsed Core Comprehensive State Groundwater Protection Program	✓	D[3]	DEM
Groundwater discharge permits	✓	A	DEM
Groundwater best management practices	✓	E	DEM
Groundwater legislation	✓	A	DEM
Groundwater classification	✓	A	DEM
Groundwater quality standards	✓	A	DEM
Interagency coordination for groundwater protection initiatives	✓	D	DEM(*)
Non-point source controls	✓	E	DEM(*)
Pesticide State Management Plan	✓	A	DEM
Pollution Prevention Program	✓	A	DEM(*)
Resource Conservation and Recovery Act (RCRA) Primacy	✓	A	DEM
Source Water Assessment Program	✓	A	DOH
State Superfund			
State RCRA Program incorporating more stringent requirements than RCRA primacy	✓	A	DEM
State septic system regulations	✓	A	DEM
Underground storage tank (UST) installation requirements	✓	A	DEM
UST Remediation Fund	✓	A	UST Fund Review Board/DEM
UST Permit Program	✓	A	DEM
Underground Injection Control Program	✓	A	DEM
Well abandonment regulations	✓	A	DEM
Wellhead Protection Program (EPA-approved)	✓	A	DEM

Programs or Activities	Check (✓)	Implementation Status(1)	Responsible State Agency(2)
Well installation regulations	✓	A	DEM-private DOH-public

(1) Implementation status:
A - Fully established
B - Under revision
C - Pending
D - Under development
E - Continuing efforts

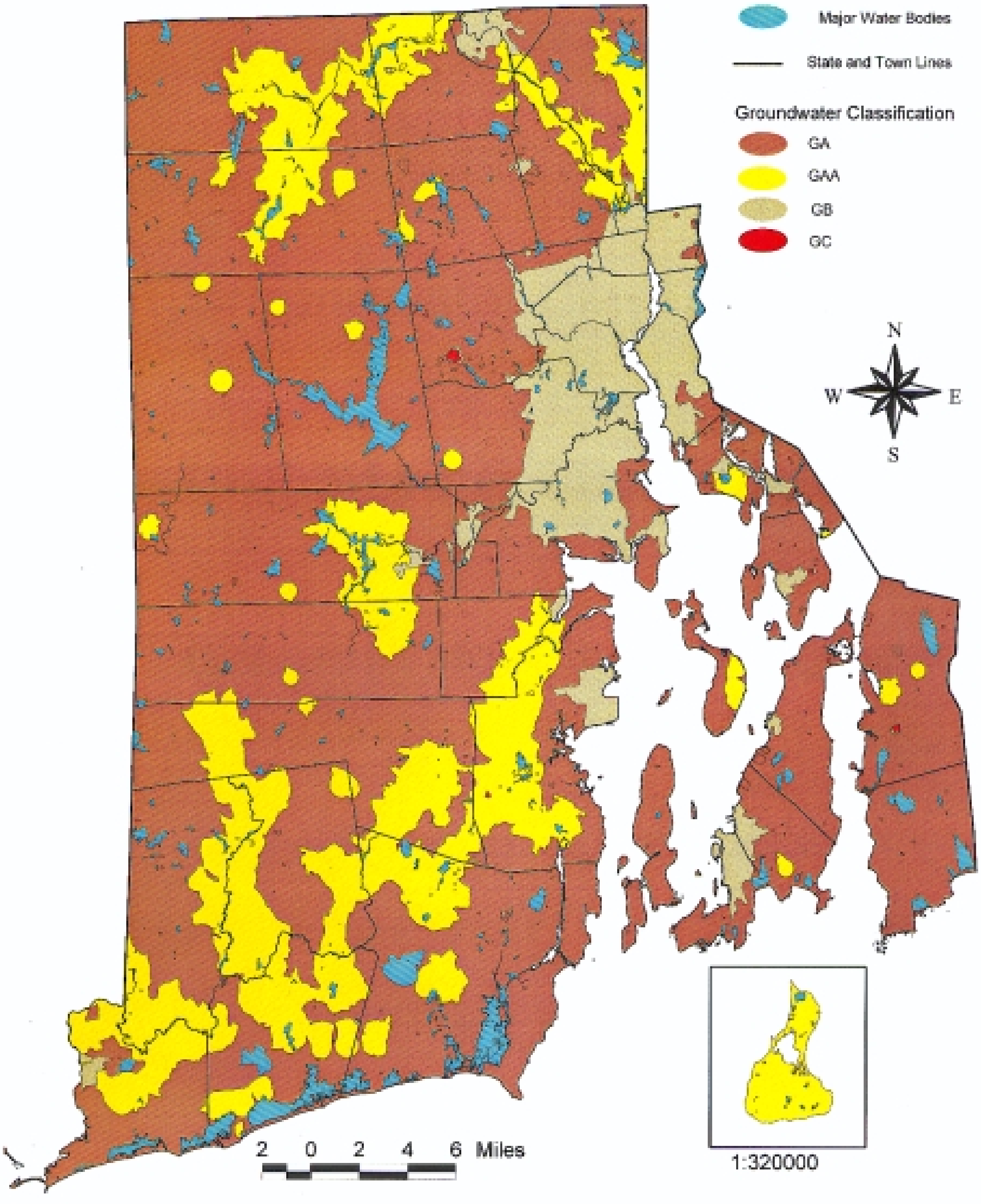
(2) Responsible agency - If multiple agencies are involved in the implementation and enforcement of a program or activity, the lead agency is indicated followed by an asterisk (*).
DEM - RI Department of Environmental Management
DOH - RI Department of Health
USGS - US Geological Survey. The Survey is a federal agency. However, since the Rhode Island Office fulfills a critical need in the state in the areas indicated, the Survey has been included in this table in order to provide a comprehensive overview of groundwater protection activities in Rhode Island.

(3) Rhode Island has a fully established comprehensive groundwater protection program. However, the report documenting the revised groundwater protection strategy that is required for EPA's endorsement of a "Core Protection Program" is scheduled for development in 2001.

Table 4-13. Rhode Island Regulations Pertaining to Groundwater

Rules and Regulations for Groundwater Quality (DEM)
Regulations for Underground Storage Facilities Used for Petroleum Products and Hazardous Materials (DEM)
Underground Injection Control Program Rules and Regulations (DEM)
Rules and Regulations Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Individual Sewage Disposal Systems (DEM)
Oil Pollution Control Regulations (DEM)
Rules and Regulations for Solid Waste Management Facilities (DEM)
Rules and Regulations for Hazardous Waste Generation, Transportation, Storage, and Disposal (DEM)
Rules and Regulations Pertaining to the Disposal, Utilization, and Transportation of Wastewater Treatment Facility Sludge (DEM)
Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (DEM)
Rules and Regulations Relating to Pesticides (DEM)
Regulations that Address Groundwater as a Source of Drinking Water Supply:
Rules and Regulations Governing the Enforcement of Chapter 46-13.2 Relating to the Drilling of Drinking Water Wells (DEM) (Note: regulations address private well installation)
Rules and Regulations Pertaining to Public Drinking Water (DOH)
Rules and Procedures for Water Supply System Management Planning (RI Water Resources Board)

Figure 4 - 9 **Groundwater Classification**



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APPENDIX

PUBLIC WELL MONITORING SUMMARY FOR GROUNDWATER ASSESSMENT AREAS

July 1, 1995 – June 30, 1999

Groundwater Assessment Area: Annaquatucket - Pettaquamscutt

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	7	7	0	0
07/01/96-06/30/97	9	7	2	0
07/01/97-06/30/98	7	7	0	0
07/01/98-06/30/99	5	4	1	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/ HA
07/01/95-06/30/96	7	7	0	0
07/01/96-06/30/97	7	7	0	0
07/01/97-06/30/98	1	1	0	0
07/01/98-06/30/99	7	7	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	0	3	5	5
0.21 – 3.0	5	4	4	3
3.1 – 4.9	0	0	0	1
5.0 – 10.0	0	0	0	0
≥ 10.0	0	0	0	0
Total	5	7	9	9

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	1	3	3	1
10.1 – 20.0	3	3	2	5
20.1 – 100	1	1	1	1
≥ 100.0	0	0	0	0
Total	5	7	6	7

Groundwater Assessment Area: Blackstone

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	16	13	3	0
07/01/96-06/30/97	13	10	3	0
07/01/97-06/30/98	8	7	1	0
07/01/98-06/30/99	5	4	1	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	13	13	0	0
07/01/96-06/30/97	13	13	0	0
07/01/97-06/30/98	10	10	0	0
07/01/98-06/30/99	20	20	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	3	5	4	4
0.21 – 3.0	10	8	15	15
3.1 – 4.9	2	3	1	1
5.0 – 10.0	2	1	0	0
≥ 10.0	0	0	0	0
Total	17	17	20	20

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	2	3	2	2
10.1 – 20.0	12	10	10	13
20.1 – 100	1	2	2	2
≥ 100.0	0	0	0	0
Total	15	15	14	17

Groundwater Assessment Area: Branch

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	39	33	6	0
07/01/96-06/30/97	25	22	3	0
07/01/97-06/30/98	16	12	4	0
07/01/98-06/30/99	11	7	4	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	13	11	2	0
07/01/96-06/30/97	17	17	0	0
07/01/97-06/30/98	13	22	1	0
07/01/98-06/30/99	12	12	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	20	23	22	17
0.21 – 3.0	15	12	15	18
3.1 – 4.9	2	1	2	0
5.0 – 10.0	0	0	0	0
≥ 10.0	0	0	0	0
Total	37	36	49	35

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	14	14	11	14
10.1 – 20.0	7	5	12	8
20.1 – 100	4	5	3	5
≥ 100.0	0	0	0	0
Total	25	24	26	27

Groundwater Assessment Area: Hunt

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	6	3	3	0
07/01/96-06/30/97	7	5	2	0
07/01/97-06/30/98	6	1	5	0
07/01/98-06/30/99	4	0	4	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	4	3	1	0
07/01/96-06/30/97	5	2	3	0
07/01/97-06/30/98	4	1	3	0
07/01/98-06/30/99	5	0	5	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	1	1	0	0
0.21 – 3.0	4	4	3	4
3.1 – 4.9	2	1	1	3
5.0 – 10.0	0	1	0	0
≥ 10.0	0	0	0	0
Total	7	7	4	7

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	0	0	0	0
10.1 – 20.0	1	1	0	1
20.1 – 100	3	3	4	3
≥ 100.0	0	0	0	0
Total	4	4	4	4

Groundwater Assessment Area: Lower Pawcatuck

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	16	14	2	0
07/01/96-06/30/97	10	8	2	0
07/01/97-06/30/98	5	5	0	0
07/01/98-06/30/99	9	6	3	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	8	8	0	0
07/01/96-06/30/97	10	10	0	0
07/01/97-06/30/98	2	1	1	0
07/01/98-06/30/99	11	11	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	2	5	4	7
0.21 – 3.0	12	11	12	9
3.1 – 4.9	1	0	1	1
5.0 – 10.0	1	1	1	1
≥ 10.0	0	0	0	0
Total	16	17	18	17

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	2	1	6	2
10.1 – 20.0	8	8	6	9
20.1 – 100	3	4	2	2
≥ 100.0	0	0	0	0
Total	13	13	14	13

Groundwater Assessment Area: Moosup

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	1	1	0	0
07/01/96-06/30/97	0	0	0	0
07/01/97-06/30/98	0	0	0	0
07/01/98-06/30/99	0	0	0	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	0	0	0	0
07/01/96-06/30/97	0	0	0	0
07/01/97-06/30/98	0	0	0	0
07/01/98-06/30/99	0	0	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	0	0	0	0
0.21 – 3.0	2	2	2	2
3.1 – 4.9	0	0	0	0
5.0 – 10.0	0	0	0	0
≥ 10.0	0	0	0	0
Total	2	2	2	2

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	2	1	1	1
10.1 – 20.0	0	0	0	0
20.1 – 100	0	0	0	0
≥ 100.0	0	0	0	0
Total	2	1	1	1

Groundwater Assessment Area: Narragansett Bay

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	17	16	1	0
07/01/96-06/30/97	18	15	3	0
07/01/97-06/30/98	7	6	1	0
07/01/98-06/30/99	0	0	0	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	5	2	2	1
07/01/96-06/30/97	3	3	0	0
07/01/97-06/30/98	6	5	1	0
07/01/98-06/30/99	10	9	1	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	10	9	8	7
0.21 – 3.0	2	4	3	5
3.1 – 4.9	3	3	1	1
5.0 – 10.0	1	2	4	2
≥ 10.0	1	0	0	1
Total	17	18	18	16

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	4	3	1	3
10.1 – 20.0	2	3	4	2
20.1 – 100	3	5	7	6
≥ 100.0	2	1	0	1
Total	11	12	12	12

Groundwater Assessment Area: Pawtuxet

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	42	35	5	2
07/01/96-06/30/97	28	22	5	1
07/01/97-06/30/98	14	10	3	1
07/01/98-06/30/99	16	12	4	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	8	8	0	0
07/01/96-06/30/97	13	13	0	0
07/01/97-06/30/98	16	16	0	0
07/01/98-06/30/99	14	14	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	18	19	20	10
0.21 – 3.0	19	21	21	14
3.1 – 4.9	4	3	4	2
5.0 – 10.0	2	3	3	5
≥ 10.0	1	0	0	0
Total	44	46	48	31

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	6	4	6	5
10.1 – 20.0	6	3	5	4
20.1 – 100	2	3	2	6
≥ 100.0	0	0	0	0
Total	14	10	13	15

Groundwater Assessment Area: South Coast

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	16	15	1	0
07/01/96-06/30/97	10	10	0	0
07/01/97-06/30/98	3	3	0	0
07/01/98-06/30/99	4	4	0	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	1	1	0	0
07/01/96-06/30/97	9	9	0	0
07/01/97-06/30/98	12	12	0	0
07/01/98-06/30/99	3	3	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	2	3	3	5
0.21 – 3.0	13	11	14	12
3.1 – 4.9	1	2	2	0
5.0 – 10.0	1	0	0	0
≥ 10.0	0	0	0	0
Total	17	16	19	17

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	9	6	8	8
10.1 – 20.0	5	6	5	6
20.1 – 100	0	0	3	2
≥ 100.0	0	0	0	0
Total	14	12	16	16

Groundwater Assessment Area: Upper Pawcatuck

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	21	16	5	0
07/01/96-06/30/97	20	15	5	0
07/01/97-06/30/98	7	4	3	0
07/01/98-06/30/99	10	8	2	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	12	8	4	0
07/01/96-06/30/97	17	12	5	0
07/01/97-06/30/98	8	7	0	1
07/01/98-06/30/99	14	11	3	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	6	6	5	5
0.21 – 3.0	8	10	9	9
3.1 – 4.9	1	1	1	1
5.0 – 10.0	0	0	1	1
≥ 10.0	0	0	0	0
Total	15	17	16	16

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	12	12	11	10
10.1 – 20.0	4	5	6	7
20.1 – 100	2	1	1	1
≥ 100.0	0	0	0	0
Total	18	18	18	18

Groundwater Assessment Area: Wood

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	16	14	2	0
07/01/96-06/30/97	17	15	2	0
07/01/97-06/30/98	7	6	1	0
07/01/98-06/30/99	11	9	2	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	7	7	0	0
07/01/96-06/30/97	8	7	1	0
07/01/97-06/30/98	16	16	0	0
07/01/98-06/30/99	12	12	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	6	9	9	8
0.21 – 3.0	11	13	13	12
3.1 – 4.9	1	1	1	2
5.0 – 10.0	1	0	1	0
≥ 10.0	0	1	1	0
Total	19	24	25	22

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	4	1	2	3
10.1 – 20.0	4	5	5	4
20.1 – 100	2	2	3	3
≥ 100.0	0	0	0	0
Total	10	8	10	10

Groundwater Assessment Area: Woonasquatucket - Moshassuck

VOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	5	4	1	0
07/01/96-06/30/97	4	4	0	0
07/01/97-06/30/98	1	1	0	0
07/01/98-06/30/99	1	0	1	0

SOC				
	Total Number of Wells Sampled	Wells with No Detection	Wells with Detection Less than MCL/HA	Wells with Detection Equal or Greater than MCL/HA
07/01/95-06/30/96	0	0	0	0
07/01/96-06/30/97	4	4	0	0
07/01/97-06/30/98	3	3	0	0
07/01/98-06/30/99	1	1	0	0

Nitrate				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 0.20	4	4	4	4
0.21 – 3.0	2	2	2	2
3.1 – 4.9	0	0	0	0
5.0 – 10.0	0	0	0	0
≥ 10.0	0	0	0	0
Total	6	6	6	6

Sodium				
Concentration (mg/l)	Number of Wells			
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99
≤ 10	0	0	0	0
10.1 – 20.0	2	2	2	1
20.1 – 100	0	0	0	1
≥ 100.0	0	0	0	0
Total	2	2	2	2